simultaneous combinatorial mechanism (AUSM) outperformed the sequential Japanese mechanism in terms of efficiency (Table 4). In the five-bidder, six-item environment -- the environment where bidders had the highest degree of heterogeneous combinatorial overlap in their valuations -- the disparity in average efficiency is most striking: 92% for AUSM, 57% for the sequential mechanism. In this environment, AUSM also produced more revenue (70% of optimum) than did the sequential mechanism (61% of optimum).

B. Bias in PCS Auction Outcomes Due to Limitations on Packaging

In general, if the Commission limits the types of combinatorial bids that can be submitted in the PCS auctions, "bias" can occur -- that is, some bidders will be disadvantaged relative to others. Experimental results in such an environment indicate that those bidders interested in obtaining combinations that are permitted to be bid for as a package are at an advantage relative to those who prefer combinations that cannot be bid for as a package.

1. Sequential and Simultaneous-Independent Auctions

The experiments indicate that packaging limitations can bias sequential auction outcomes. In experiments involving eleven bidders with nine licenses to be assigned, this bias was clearly evident. As noted above, bidders were allowed to submit a sealed

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much of the observed bidding behavior should be attributed to learning effects.

bid for all nine licenses prior to sequential Japanese auctions for each of the individual licenses.[50/] In trials in which the highest collective valuation was larger than the sum of the highest individual valuations for the licenses, the economically efficient allocation was achieved. However, when the sum of the highest individual valuations was higher than the highest package valuation for all of the licenses, the efficient allocation was achieved three of nine times -- that is, the package bidder won the auction six of nine times. (See starred entry, Table 5). In other words, adding the sealed package bid for all licenses biased the outcome of the sequential auctions in favor of the package bidder.

Auction bias is also a problem in simultaneous-independent auction environments in which only single-item bids are permitted. In separate trials using the same nine-item, eleven-bidder experimental environment described above, auction outcomes were biased in favor of non-combinatorial bidders (Table 5). In two of seven trials in which the optimal allocation[51/] required that one bidder be assigned all nine licenses, this bidder did not attempt to assemble such a package (presumably for fear of losing money by assembling only a partial package). Caltech researchers call this an "exposure problem."

50/ In this section, we focus only on Dr. Plott's experiments in which bidders had valuations for the nine-item collection and for each item individually.

51/ "Optimal" refers to the allocation that maximizes the total valuation of all licenses, given the valuations of all of the bidders.

Allowing bids on only single-item packages may seem "fair," but fear of financial exposure on the part of bidders trying to amass large combinations may impair the performance of simultaneous-independent mechanisms. We also note that when the large combination bidder did assemble its complete package, it often did so at a price higher than the sum of the highest valuations for individual licenses. This indicates that some bidders were willing to bid above their valuations for individual licenses in an attempt to drive up the total price paid by the bidder trying to obtain all nine licenses.[52/] A summary of auction bias results for sequential Japanese and simultaneous-independent auctions in the nine-item environment appears in Table 5.[53/]

52/ We do not wish to over-emphasize the problems with simultaneous-independent mechanisms. The experiments indicate that these mechanisms perform better than sequential mechanisms. In a sequential auction mechanism, bidders have two problems. As in the simultaneous-independent mechanism they can submit bids on only individual items. In addition, they are plagued by a high degree of uncertainty about the prices of items to be auctioned later in the sequence. This uncertainty is alleviated in simultaneous auctions.

53/ The sequential Japanese auctions summarized in Table 5 ordered the items in terms of expected value from largest to smallest. Dr. Plott conducted experiments on Japanese auctions in which the items were ordered randomly, and simultaneous auctions that offered bidders no release provisions. The results for these experiments and notes on his experimental design appear in Appendix A.

TABLE 5: FREQUENCY OF CORRECT PACKAGE ASSEMBLY

	Number of Times Highest-Valued Package Assembled	
	Japanese Auction with Sealed Package Bid for All Items	Simultaneous-Indep. Auction with Release Provision
Nine-item Package Value > Sum of the Highest Valuations on Individual Items	7/7	5/7
Nine-item Package Value < Sum of the Highest Valuations on Individual Items	3/9*	8/8

Note- AUSM was not tested in the nine-item, eleven bidder environment.

These bias results are also reflected in the average efficiencies (expressed as a percentage of the optimal allocation) that each mechanism produced in fourteen experiments in which direct comparison of the simultaneous with the sequential Japanese mechanism is possible (Table 6). The sequential mechanism achieved relatively lower efficiencies when the sum of the highest individual valuations was greater than the highest collective valuation -- 86.3% of optimum versus 97.6%. When the reverse was true, the simultaneous-independent mechanism achieved relatively less efficient allocations -- 92.2% versus 98.5%.

TABLE 6: EFFICIENCY COMPARISONS BETWEEN SEQUENTIAL JAPANESE AND SIMULTANEOUS-INDEPENDENT AUCTIONS

	Average Efficiency of Final Assignments as a Percent of Optimum	
	Japanese Auction with Sealed Package Bid for All Items	Simultaneous-Indep. Auction with Release Provision
Nine-item Package Value > Sum of the Highest Valuations on Individual Items	98.5%	92.2%
Nine-item Package Value < Sum of the Highest Valuations on Individual Items	86.3%	97.6%

Note- The fourteen experiments used to construct the percentages in this table are not necessarily the experiments described in Table 5.

2. Simultaneous-Combinatorial Auctions

We disagree with some criticisms of the NTIA proposal that suggest that permitting bids on all combinations of licenses can introduce bias in auction outcomes.[54/] In particular, some contend that permitting combinatorial bids creates a free-rider problem for bidders looking to combine small combinatorial bids to defeat a large combinatorial bid. Their argument, in essence, is that the need to bid against a large bidder is a burden shared by all the

54/ See, e.g., Milgrom & Wilson, supra note 17, at 6-7.

small bidders, but each small bidder prefers to let other bidders bear the lion's share of such a burden.[55/]

The experimental evidence indicates that full combinatorial bidding, with a stand-by queue, mitigates the free-rider problem. In experiments conducted using AUSM, small bidders were generally able to coordinate their bids through the stand-by queue to "bump off" large combinatorial bids in those instances where the sum of the small bidders' valuations was higher than that of the large bidder. These results, moreover, appear robust to changes in the experimental environment.

A bias in favor of the combinatorial bidder occurred only in certain instances in which the sum of valuations of small bidders was only slightly higher than that of the large combinatorial valuation. Because the valuations were so close, however, efficiency suffered only slightly in these instances. AUSM produced average efficiencies of greater than 90% in each of the three environments (Table 7). By contrast, a simultaneous-independent mechanism[56/] produced less efficient allocations than

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55/ Dr. Ledyard of Caltech suggests that this free-rider problem is more properly called a "threshold" problem. In free-rider problems, the dominant strategy for bidders is never to provide any of the public good. However, in the PCS environment, it may be in the bidder's best interest to contribute to the effort to surpass the "threshold" created by the large combinatorial bidder.

56/ This environment was based on the auction proposal by Milgrom and Wilson.

AUSM in each of the three environments.[57] Clearly, the "strict" withdrawal rule discussed above[58] contributed to the low efficiencies for this auction form in Table 7. In the 5x6 environment, which had the most fitting and overlap problems, and may, therefore closely mimic bidder valuations in actual PCS auctions, AUSM produced a 92% average efficiency while the simultaneous-independent mechanism produced 64%.

TABLE 7: EFFICIENCY AND REVENUE COMPARISONS BETWEEN AUSM AND SIMULTANEOUS-INDEPENDENT AUCTIONS

Environment	Mechanism	Average Efficiency (as a % of optimum)	Average Revenue (as a % of optimum)
3 X 3	AUSM	92%	73%
	Simul.-Indep.	78%	41%
5 X 6	AUSM	92%	70%
	Simul.-Indep.	64%	51%
10 X 54	AUSM	100%	74%
	Simul.-Indep.	93%	56%

57/ If one compares the sequential results of Table 4 with the simultaneous-independent results in Table 7 for the 3x3 and 5x6 experiments, it would appear that the two mechanisms perform roughly equivalently. Recall, however, that the simultaneous-independent trials summarized in Table 7 employed a strict bid withdrawal rule. When a less restrictive "release provision", see supra pages 35-36, was used (11x9 environment), the simultaneous-independent mechanism outperformed the sequential Japanese auction. This underlines the need for further research on bid withdrawal rules in simultaneous-independent auctions.

58/ See supra page 38.

One bit of experimental evidence suggests that Milgrom and Wilson are correct in suggesting that large combinatorial bidders might employ "jump bids" in an attempt to disadvantage smaller bidders.[59/] A jump bid is a preemptive bid submitted by a large combinatorial bidder which is much larger than that necessary to surpass the sum of the present smaller combinatorial bids. The large combination bidder submits this bid to maximize the bidding coordination difficulties between the smaller bidders. In one of the three trials of the AUSM mechanism in the 54-unit environment, a bidder submitted such a bid for all 54 items. However, the smaller bidders (whose summed valuations were higher than the large bidder's in this particular trial) were able to coordinate through the stand-by queue to defeat the 54-item package bid. Although only one trial, this too suggests that free-rider critiques of AUSM are overstated.

59/ See Milgrom & Wilson, supra note 17, at 6-7.

USES OF LABORATORY EXPERIMENTAL METHODS IN THE DESIGN OF THE PCS AUCTION

(January 27, 1994: California Institute of Technology)

Charles R. Plott
California Institute of Technology

I. The Why and How of Laboratory Methods In Economics

a. Incentives (money), Procedures (the rules of the game), Performance Measures (efficiency and distribution)
b. An electronic double auction (demonstration on network from lab.)
c. Demonstration of types of equilibration in markets (the nature of principles of economic behavior)
(i) Equilibration to fundamentals of underlying supply and demand
(ii) Bubbles and expectations equilibria (and the sharp adjustments between types of equilibria)
d. The importance of auction rules, institutions, and organization and the importance of simple case studies
- the EPA SO_2 auction as an example of a poorly designed auction process

II. Special Electronic Auction Processes Related to the Spectrum Auction (a demonstration of the actual electronic markets in operation)

a. A type of combinatorial auction - a railroad track allocation auction (demonstration on the network from the laboratory)
b. An electronic Japanese auction (demonstration on the network from the laboratory)
c. An electronic simultaneous auction (demonstration on the network from the laboratory)
d. Examples of real time operation of the auctions (sped-up for presentation purposes)

III. Comparisons of Auction Performance

a. Parameters

(1) **Series 1:** nine items:
(i) super additive value of collection of all items less than the sum of 1st values of independent items
(ii) super additive value of collection of all items greater than the sum of 1st values of independent items
(2) **Series 2:** nine items:
(i) super additive value of 2 collections of three items, value of collection of items less than the sum of 1st values of independent items

(ii) super additive value of 2 collections of three items, value of collection of items greater than the sum of 1st values of independent items

(3) **Series 3:** nine items:

(i) super additive value of collection of all items randomly above and below sum of 1st values of independent items

(ii) expected value of items provided as public information

b. Institutions

(1) Japanese auction in random order with sealed bid for a single package (opened prior to individual auctions)

(2) Simultaneous auctions for all items (with and without release-to-market provision)

(3) Japanese auction in order from highest to lowest with sealed bid for a package of seven items (opened prior to individual auctions)

c. Results

(1) A sealed bid for a selective package (with a sequential Japanese auction for individual items) gives an advantage to the bidder that wants that package.

(i). The sealed bid process always produces an assembled package when one should be assembled and it frequently produces an assembled package when one should not be assembled. Under the sealed bid an assembled package is always profitable whether it should have been successfully produced by the process or not.

(ii). The existence of a sealed bid harms the profits of the items that come late in a sequence of auctions.

(iii). The existence of the sealed bid can cause inefficiencies in the system even when it loses.

(2) Sequential auctions without a sealed bid make package assembly very risky.

(3) Independent experiments with sequential auctions demonstrate that efficiency is low (relative to simultaneous auctions or serial dictator processes) when confronted with the assignment problem.

(4) Package assembly frequently does not occur when it should in simultaneous auctions with no release provisions. The individual with the package value frequently does not try to assemble one and when attempted the assembly is risky.

(5) When a release provision is added to a simultaneous auction the frequency of attempts to assemble the package goes up and the successes go up to high levels. Successful assembly is always profitable.

(6) Under the simultaneous auction, when packages should not be assembled they are never successfully assembled.

SUMMARY STATISTICS : Package Assembled and Profitable

THREE ITEM COLLECTIONS: NUMBER OF PERIODS

		Japanese Auction with Sealed Pkg bid	Japanese Auction no Pkg bids	Simultaneous Auction with Release Provision
PkgV >Sum 1st	collection assembled	**2 / 2**	**2 / 2**	**5 / 6**
	collection profitable	**2**	**1**	**5**
PkgV <Sum 1st	collection assembled	**5 / 10**	**0 / 10**	**0 / 6**
	collection profitable	**5 / 5**		

NINE ITEM COLLECTIONS: NUMBER OF PERIODS- No Special Order

		Japanese Auction with Sealed Pkg bid	Simultaneous Auction with no Release Provision	Simultaneous Auction with Release Provision
PkV >Sum 1st	collection assembled	**2 / 3**	**4 / 9**	**3 / 4**
	collection profitable	**2**	**2**	**3**
PkV <Sum 1st	collection assembled	**5 / 15**	**0 / 8**	**0 / 3**
	collection profitable	**5**		

NINE ITEMS COLLECTIONS: NUMBER OF PERIODS- Ordered by (Exp) Value

		Japanese Auction with Sealed Pkg bid	Simultaneous Auction with Release Provision
PkgV > Sum 1st	Pkg Assembled	**7 / 7**	**5 / 7** [Two never tried to get the collection.]
	Pkg Profitable	**7**	**4**
PkgV < Sum 1st	Pkg Assembled	**6 / 9**	**0 / 8**
	Pkg Profitable	**6**	

INSTRUCTIONS: ITEMS

01/14/94

This is an experiment in the economics of market decision making. The instructions are simple and if you follow them carefully and make good decisions you might earn money which will be paid to you in cash.

In this experiment several items will be sold in a sequence of market days or trading periods. The items to be sold are designated by letters of the alphabet (A, B, C, etc...). You may purchase any number of items as you wish. Attached to these instructions you will find a set of sheets labeled **REDEMPTION VALUES** that will help you determine the value to you of any collection of items that you might purchase. The values applicable to different periods are on different sheets. The information on the redemption value sheets is your own private information. Do not reveal it to anyone.

The profits to you of any collection of items that you may purchase is the difference between the redemption value of the collection and the amount you paid for the collection.

i.e. PROFIT = REDEMPTION VALUE OF ITEMS - PURCHASE PRICE OF ITEMS

For example, suppose you purchased only item B in a period. In order to determine your profits for the period you subtract the purchase price for the item, in this case item B, from the redemption value for the item. If the redemption value of B was 10 and you paid 8 for B, then your profit for the period would be 2.

The redemption value of a collection of items may be different from the sum of the redemption values for each individual item in the collection. Suppose for example that your redemption value sheet appeared as below:

Item	Redemption Value
A	10
B	10
C	5
BC	24
AB	16
ABC	40

VALUE OF UNLISTED COLLECTIONS = value of items in the collection.

For example the value of B and C added separately is 10+5=15 but the value of the collection BC is 24. Now suppose that you paid 8 and 9 for items B and C, respectively, for a total expenditure of 17. Then your profits would be

$$24 - 17 = 7.$$

That is, value of Collection BC - sum of prices paid for B and C = period profit.

Notice that the redemption value of a collection might be greater than the sum of the values of the items in the collection (e.g. BC), equal to the value of the collection (e.g. AC) or less than the value of the collection (e.g. AB). Each period check carefully the redemption value for the collections.

The profit to you if you acquire a collection is the redemption value of the collection minus whatever you paid for the individual items. If you purchase more than one item then a convention is necessary for determining those items that are considered to be collections and those that are to be considered to be individual items. In the markets to follow the rule will be: you are free to divide items into collections as you may want.

Be sure to check carefully the values of collections before making purchases.
You should also check each period to make sure that you are using the proper redemption value sheet for the period.

Sequential Japanese auctions with sealed bids for packages
011294

Items will be auctioned sequentially beginning with item A. A price "clock" will be displayed on your computer as reproduced on the chalkboard. The price will start low and move up in increments of ____ each ____ seconds. Shown at the right of the price clock is a window which shows what the price will be after the next movement. A second window contains an indicator of the amount of time before the price change will take place.

At any time during the auction an individual has the opportunity to remove himself/herself from the auction by pressing the [ESC] key. Those that have not decided to exit the auction are expressing a willingness to pay the amount shown on the price clock. The price clock will stop when only one individual remains in the auction and the item will be sold to the remaining individual at the price on the clock.

Suppose for example the auction contains four people and that the price clock is ascending 10, 12, 14, 16, 18 . All four are in the auction at 10. One person exits at 12 leaving three in the auction. Another person presses the [ESC] key at 14 leaving two people in the auction. If the third person presses the [ESC] key at 18 the price clock will stop immediately and the item will be sold to the 4th person at 18 (If there are no sealed bids to consider).

The auction of the items will have a sealed bid phase. Before the auction for any item begins, any individual that wants to bid on a package of ALL nine items can do so. The bids for the package of all items {A,B,C,...,I} will be written on a form and handed to the auctioneer. The bids will be opened and announced. The clock auctions for the individual items will then begin. If the sum of the prices of the individual items as determined by the price clock auctions is greater than the highest sealed bid for the package of all items, then the items will be sold independently to the individuals that were the final bidders in the clock auctions at the prices determined by the clock auctions. If the highest sealed bid is greater than the sum of the prices in the individual clock auctions then all items are sold as a package to the high bidder at the price of the sealed bid.

Progressive, simultaneous auctions (with release)
011294

Bids for items will be entered through your computer. The screen is reproduced on the chalkboard. Each of the items {A,B,C,D,E,F,G,H,I} is listed in a column. To the right of each item is the current bid on that item. Bids are submitted by first entering the letter of the item for which you wish to place a bid as prompted at the bottom of the screen. You should then enter the amount that you wish to bid using the number keys. Press [F1] to send the bid to the market and press [backspace] to erase. If your bid is above the current bid it will replace the current bid and if not it will be rejected. The screen will not indicate who has made bids but it will indicate to you which bids are yours. You may place as many bids as you wish and you may bid on as many items as you wish

A time clock is shown on your screen. After each accepted bid the time clock is reset for 15 seconds and a countdown begins. If the clock reaches zero then all items are sold to the existing bidders at the bid price. That is, if 15 seconds elapses without an increase in the bid for some item then all markets are closed and all items are sold to the highest bidders.

In some cases an individual wants to undertake a change in strategy after having acquired some items and would prefer to not purchase some of the items already acquired. By entering [Alt and the item letter] the individual has the ability to restart the auction for that item at a zero price. Other individuals will then be allowed to bid in the ordinary fashion. In taking this action of releasing an item the individual is obligated to pay the difference between the price at which the item was released and the final price at which the item is sold. If the final price is greater than the release price then the individual pays nothing. An individual who releases an item will be prohibited from bidding on that item during the remainder of the period.

INSTRUCTIONS

AUSM (3X3)

You are about to participate in an experiment in which you will make decisions in a market. Your decisions will result in earnings in U.S. currency which will be yours to keep. In this experiment all transactions will be stated in *francs*. You can convert your franc earnings into U.S. dollars at a rate of ____ francs to 1 dollar at the end of the experiment.

The experiment will be broken-up into a series of **periods**. Each period in turn will be divided into a series of **rounds** in which you will make decisions. At the beginning of each period you will be given a **Redemption Value Sheet** which describes the value to you of decisions you might make. *You are not to reveal this information to anyone.*

How to Read a Redemption Value Sheet

A Redemption Value Sheet is a list of **packages of items** (the items are labeled as A, B and C) and its value to you in francs. Below you will find a sample Redemption Value Sheet with four packages (the packages are identified as a, b, c and abc) which contain a specific configuration of items.

REDEMPTION VALUE SHEET

	Items			
Package Name	A	B	C	**Value in Francs**
a	Y	N	N	60
b	N	Y	N	49
c	N	N	Y	29
abc	Y	Y	Y	142

You may only redeem one package per period. For example, in the above sheet, package abc consisting of the items A, B and C has a value of 142 francs. However, if you were only to obtain items A and C you would receive at most 60 francs. Your earnings for a period are the value of the package you want to implement at the end of the period, for which you have obtained the items in that package, minus your cost of obtaining the items.

How the Redemption Values are Determined

You will be one of 3 participants in this market. At the beginning of a period each participant will have his or her values determined by the following procedure:

1. A **base value** number from the interval [0,49] will be independently selected for each participant. Each value in this interval will be equally likely to be selected.
Example:
Participant 2 gets the base values of 47 for items A, B, and C.
Participant 3 gets the base values of 16 for items A, B, and C.

2. The **redemption value** for each of the single item packages a, b, and c is determined by adding a number selected separately and independently for each of these packages from [0,49], all of which are equally likely.
Example:
Participant 2 gets the redemption values of 61 (47 + 14) for package a, 67(47 + 20) for package b, and 74 (47 + 27) for package c.
Participant 3 gets the redemption values of 35 (16 + 19) for package a, 18 (16 + 2) for package b, and 31 (16 + 15) for package c.

3. The redemption value for the package abc is determined by taking the largest redemption value obtained and adding a number from the interval [0,149] all of which are equally likely.

Example:

Participant 2 gets the value 119 (74 + 45) for the package abc.

Participant 3 gets the value 128 (35 + 93) for the package abc.

Summary to this Point

- At the beginning of each period, each participant will be given a Redemption Value Sheet of values for each item A, B and C along with a value for the three item package abc.

- The value for each single item package has the same base value number from [0,49] plus an amount taken independently from [0,49] for each item. Thus, over many draws the average value for a single item package is 49.

- The value for the package with A, B and C will be a number between [0, 247], all of which are not equally likely. The values are distributed as follows (the average over many draws is 135):

Value is greater than	Chance that this can occur
50	98 out of 100
100	74 out of 100
150	40 out of 100
200	9 out of 100

- The sequence of events are as follows:

Period 1 begin Obtain Redemp. Val.	Bidding Rounds for Period 1	Bidding Ends Record Profits	Period 2 begin Obtain Redemp. Val.

The Bidding Process

At the beginning of each period, round 0 will open for you to submit bids to the market, in francs, for packages containing the items A, B and C. You can submit bids on any combination of the items. For example, you could submit a bid for the package with items A and C for a price of 20, as depicted below:

A Sample Bid

A	B	C	$
X		X	20

The bid will be provisionally accepted if its price is greater than the sum of the bids it must displace. For example , suppose the set of provisional bids were as depicted below: Participant 1 has bid for item A for a price of 20 and participant 2 has bid for the package BC for a price of 30. If you wanted a package with items A and C to be provisionally accepted you would have to bid a price over 50 in order to ***bump*** participants 1 and 2.

Provisionally Accepted Bids in Round 1

Participant	A	B	C	$
1	*X*			*20*
2		*X*	*X*	*30*

The provisionally assigned packages and bids will be posted for all participants to see. In addition to submitting bids directly to the market, you can submit binding bids to a ***standby queue***. Only the highest bids for packages submitted to the standby queue will be listed. The standby queue is provided to allow participants to signal there willingness to "combine" bids to get assigned. Only the best bids are displayed. For example, suppose that participant 2 has a bid on the standby queue for item B at a price of 10 as depicted below. If you wanted the package AC to be provisionally accepted, you would only have to submit a price greater than 40 to the market. Once the combined orders are sent to the market, they bump the previous accepted bids but are listed separately.

Standby Queue

Participant	A	B	C	$
2		X		10

Example:

Participant 3 "combines" his bid for AC with price 41 together with participant 2's bid in the standby queue.

RESULT OF THE BUMP

New Provisionally Accepted Bids in Round 1

Participant	A	B	C	$
3	***X***		***X***	***41***
2		***X***		***10***

After the market has been open for a few minutes in a round we will pause the period. <u>During the pause no new bids can be sent to the market.</u> At the beginning of the pause you can delete your bids in the standby queue. New binding bids can then be submitted to the standby queue during the pause. After a short period of time the next round in the period will open.

The period will end if the following condition occurs:

No new bids enter the market that are 10% over the bids they bump within 3 minutes.

If condition does not occur, the bidding process will continue for the period. When the process stops the items are awarded to those individuals (**assigned participants**) who are part of the current provisionally assigned participants.

Summary of the bidding process

1. At the beginning of each round in a period each participant can send in bid packages to the market or standby queue.
2. A bid sent to the market will be accepted if its price is higher than the sum of prices of the package that it must displace.
3. You can "combine" your bid with any of those on the standby queue and send them to the market.
4. In a round of a period, the market will be open for several minutes. It will then close temporarily and only standby bids can be submitted.
5. Next the period will be reopened for bidding in the market and standby queue.
6. The period will stop if there are no new bids within 3 minutes.

Accounting for your Profits

When the period ends you fill out your period account line by listing the Redemption Value for the package you where assigned and subtract its bid. For example, suppose Participant 2 was assigned, in period 1, items A and C with winning bids of 20 and 30 respectively. The value for the package is the maximum of the values for the single item packages (60 for our example).

ACCOUNTING SHEET

Period	Items Assigned	Value of Package		Your Winning Bids	Profit
1	A, C	60	-	50	= 10
			-		=
			-		=

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.
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INSTRUCTIONS

Simul.-Indep. (3X3)

You are about to participate in an experiment in which you will make decisions in a market. Your decisions will result in earnings in U.S. currency which will be yours to keep. In this experiment all transactions will be stated in *francs*. You can convert your franc earnings into U.S. dollars at a rate of ____ francs to 1 dollar at the end of the experiment.

The experiment will be broken-up into a series of **periods**. Each period in turn will be divided into a series of **rounds** in which you will make decisions. At the beginning of each period you will be given a **Redemption Value Sheet** which describes the value to you of decisions you might make. *You are not to reveal this information to anyone.*

How to Read a Redemption Value Sheet

A Redemption Value Sheet is a list of **packages of items** (the items are labeled as A, B and C) and its value to you in francs. Below you will find a sample Redemption Value Sheet with four packages (the packages are identified as a, b, c and abc) which contain a specific configuration of items.

REDEMPTION VALUE SHEET

	Items			
Package Name	A	B	C	**Value in Francs**
a	Y	N	N	60
b	N	Y	N	49
c	N	N	Y	29
abc	Y	Y	Y	142

You may only redeem one package per period. For example, in the above sheet, package abc consisting of the items A, B and C has a value of 142 francs. However, if you were only to obtain items A and C you would receive at most 60 francs. Your earnings for a period are the value of the package you want to implement at the end of the period, for which you have obtained the items in that package, minus your cost of obtaining the items.

How the Redemption Values are Determined

You will be one of 3 participants in this market. At the beginning of a period each participant will have his or her values determined by the following procedure:

1. A **base value** number from the interval [0,49] will be independently selected for each participant. Each value in this interval will be equally likely to be selected.

Example:

Participant 2 gets the base values of 47 for items A, B, and C.

Participant 3 gets the base values of 16 for items A, B, and C.

2. The **redemption value** for each of the single item packages a, b, and c is determined by adding a number selected separately and independently for each of these packages from [0,49], all of which are equally likely.

Example:

Participant 2 gets the redemption values of 61 (47 + 14) for package a, 67(47 + 20) for package b, and 74 (47 + 27) for package c.

Participant 3 gets the redemption values of 35 (16 + 19) for package a, 18 (16 + 2) for package b, and 31 (16 + 15) for package c.

3. The redemption value for the package abc is determined by taking the largest redemption value obtained and adding a number from the interval [0,149] all of which are equally likely.

Example:

Participant 2 gets the value 119 (74 + 45) for the package abc.

Participant 3 gets the value 128 (35 + 93) for the package abc.

Summary to this Point

• At the beginning of each period, each participant will be given a Redemption Value Sheet of values for each item A, B and C along with a value for the three item package abc.

• The value for each single item package has the same base value number from [0,49] plus an amount taken independently from [0,49] for each item. Thus, over many draws the average value for a single item package is 49.

• The value for the package with A, B and C will be a number between [0, 247], all of which are not equally likely. The values are distributed as follows (the average over many draws is 135):

Value is greater than	Chance that this can occur
50	98 out of 100
100	74 out of 100
150	40 out of 100
200	9 out of 100

• The sequence of events are as follows:

Period 1 begin Obtain Redemp. Val.	Bidding Rounds for Period 1	Bidding Ends Record Profits	Period 2 begin Obtain Redemp. Val.